Reviews

SUMMARY OF THE LITERATURE OF NORTH AMERICAN PLEISTOCENE GEOLOGY. 1901 AND 1902.

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IN the two years covered by this summary there have been published in the neighborhood of 150 papers and reports (a few of which the reviewer has been unable to obtain), which either wholly or in part discuss features or problems of North American Pleistocene geology. About forty papers pertain to the Dominion of Canada, and half as many to Alaska and the Cordilleran part of the United States, while nearly every state which falls within the limits of glaciation has had notice in from one to fifteen papers. Iowa appears to lead the states in number of papers published, though New York is but little behind, and Massachusetts, Michigan, Indiana, and Wisconsin have a good showing. New Jersey has been favored by the appearance of a voluminous report on glacial geology, while Ohio and parts of neighboring states are embraced in a monograph by the United States Geological Survey dealing entirely with the glacial formations and drainage features. Kansas and Minnesota have had a little notoriety in connection with the question of glacial man. A large number of papers have been brief contributions to magazines or to the bulletins, transactions, and proceedings of scientific societies or academies which deal usually with a small territory or a single subject. The official reports published by the state, United States, and Canadian surveys which contain matter on Pleistocene geology also in most cases give a large share of attention to the geology of the older rock formations. In such cases this review is confined to the Pleistocene portion. Inasmuch as each area has to some extent problems of its own, it has seemed advisable to group the papers areally. There is also a group composed of papers of a general nature.

THE CORDILLERAN REGION IN CANADA.

BROCK, R. W. *The Boundary Creek District, British Columbia.* Geol. Surv. Canada, Summary Rept. for 1901, pp. 49–67, 1902.

The area examined was confined to the Grand Forks and Kettle River mining divisions of the boundary district. Glaciation is discussed mainly on p. 57. None of

the mountains are of sufficient altitude to support glaciers now, but glacial phenomena due to the Cordilleran ice-field are everywhere strikingly evident. The average direction of striation when uninfluenced by local causes is about S, 30° E. Drift "terraces" are numerous at all altitudes, up to 2,000 feet above the valleys. Since glaciation the surface oxidation and weathering has been very slight.

DALY, R. A. *Geology of the Region Adjoining the Western Part of the International Boundary.* Geol. Surv. Canada, Summary Rept. for 1901, pp. 37–49, 1902.

The area discussed embraces a tract eighty miles from west to east and ten miles in width on the north side of the international boundary from the Gulf of Georgia eastward. The glacial geology is mainly treated on pp. 41–5, and embraces a brief discussion of glacial erosion and denudation, cirques, mountain tarns, and small lakes, river terraces, and deltas. A morainal dam which holds in Chilliwack lake is also described. This lake stands 1,850 feet above the sea, and the granite walls rise steeply 3,000 to 4,500 feet higher, with truncated spurs between tributary gulches that indicate a large amount of glacial erosion.

GWILLIM, J. C. *Glaciation in the Atlin District, British Columbia.* Jour. Geol., Vol. X, pp. 182–5, 1902.

The great valleys of northern British Columbia show evidence of glacial action which occurred after the valleys had reached about their present dimensions. There appears to have been regional glaciation followed by a partial or local glaciation. There is also a present active glaciation in coast ranges to the westward. The regional glaciation left its marks on the slopes up to an altitude 5,000 feet above the valleys, and the movement was northward. The local glaciation was restricted to the upper valleys and slopes, but did not cover the high parts of mountains.

The paper closes with a brief description of the Llewellyn glacier near Atlin lake. The upper surface of the ice-field is about 5,000 feet above sea level or 3,000 feet above Atlin lake.

MCCONNELL, R. G. *The Yukon District.* Geol. Surv. Canada, Summary Rept. for 1901, pp. 23–37, 1902.

Results of examinations at several of the smaller placer camps in the Yukon district are presented. Livingston creek valley shows evidence of glacial action in its upper part and heads in a steep amphitheater. In most of the creek valleys the terraces and terrace material are reported to consist of ordinary stream wash, and no mention is made of glacial action.

PARKINSON, J. *Some Lake Basins in Alberta and British Columbia.* Geol. Mag., Decade 4, Vol. VIII, pp. 97–101, 1901.

Lake Agnes in the Canadian Rocky mountains is found to be in a rock basin. Mirror lake, into which it discharges, is not so clearly a rock basin. Lake Louise, farther down the valley, probably receives the discharge from Mirror lake by underground channels. Whether Lake Louise is a rock basin is not certain. Lake Marion in the Selkirk range is another case in which the evidence is not clear as to its being a rock basin. Among the agencies which may have been operative in producing the Lake Agnes rock basin, warping, glacier erosion, and decay of soft rocks in the upper end of the basin should be considered. The soft rocks might have been removed either by stream or glacier action.

VAUX, GEORGE, and WILLIAM, S., Jr. *Observations Made in 1900 on Glaciers in British Columbia.* Proc. Phil. Acad. Nat. Sci., for 1901, pp. 213–15.

Notes on the movements of the glaciers are presented.

ALASKA.

BROOKS, A. H., and COLLIER, A. J. *Glacial Phenomena of the Seward Peninsula.* Abstract, Science, N. S., Vol. XIII, 1901, pp. 188, 189.

No evidence of general glaciation was found, but there were centers of local glaciation. The valleys of the Kiglow-aik range are glaciated to 500 feet above the valley floors, and the moraines were deposited close to tide water. Shrunken remnants of some of the glaciers still persist, and are, so far as known, the most northerly in Alaska, being in latitude 65°. There is evidence of a recent elevation of 600 to 800 feet, but it antedates the maximum extension of the glaciers.

BROOKS, A. H. *Sketch of the Geology of Southeastern Alaska.* Professional Paper No. 1, U. S. Geol. Surv., pp. 31–3, 1902.

Existing glaciers are found chiefly on the Pacific mountain system, and the largest development is on the seaward slope. On the Pacific side of the St. Elias range the perpetual snow limit is about 2,000 feet, and on the inland slope about 6,500 feet. The glaciers on the Pacific slope are much larger than on the inland slope. The Coast Range has less conspicuous glaciers than the St. Elias, and they are mainly on the seaward slope.

The extent of former glaciation was much greater than at present, though its limits were fully determined at but few points. It is not known whether the higher mountains were covered. On Prince of Wales Island glacial action was found up to 2,200 feet, but near Niblack Anchorage it seems to have reached no higher than 2,000 feet. In general the Alexander Archipelago was glaciated up to at least 2,000 feet. Farther north glaciation reached higher altitudes, there being glacial bowlders near Juneau at 3,200 feet, and this town stands on a moraine. Terraces along the valley walls of Chilcat and one of its tributaries are thought to have been built while the valley was still occupied by glacier ice. Rock-cut basins occupied by lakes are not uncommon, especially in the Ketchikan region. On Prince of Wales Island is a lake basin a mile long and a quarter of a mile broad entirely surrounded by a rock rim.

BROOKS, A. H., RICHARDSON, G. B., COLLIER, A. J., and MENDENHALL, W. C. *Reconnaissances in the Cape Nome and Norton Bay Regions, Alaska, in 1900.* House Doc., No. 547, 56th Cong., 2d Sess., 222 pages, 1901.

The surface geology is briefly discussed on pp. 41–7 under the topics: river and stream gravels, beach deposits, terrace deposits, glacial deposits, extra-morainic drift, ground ice, and soil. No evidence of regional glaciation was found, but four local centers of glacial action are reported. Of these the most important is in the Kiglu-aik mountains. There the valley slopes are glaciated up to an elevation 500 to 600 feet and head in glacial cirques, while at the margin typical moraines were found. Remnants of glaciers still persist in the higher mountain valleys. The extra-morainic drift found in the vicinity of Nome reaches an altitude of 800 feet. It is not necessarily

glacial, but may have been brought by ice-floes at a time when the land stood about 800 feet lower than now. A subsidence of that amount would greatly change the contours of the coast and make islands of part of the mainland.

The Norton Bay region has suffered no general glaciation, but may have carried small local glaciers.

COLLIER, A. J. *Reconnaissance of the Northwestern Portion of the Seward Peninsula, Alaska.* Professional Paper No. 2, U. S. Geol. Surv. 68 pages, 1902.

Surface deposits are discussed on pp. 24–9. Aside from the sand and gravel along the coastal plain and the streams, there are a few places where rounded pebbles and washed gravel occur at high altitudes remote from streams. There has been but little glaciation in the mountains of this region.

Evidences of uplift and warping are discussed on pp. 34–43. The plateaus, benches, and plains indicate four extensive cycles of uplift and erosion, all of which are post-Mesozoic.

GANNETT, HENRY. *General Geography of Alaska.* Harriman Alaska Expedition, pp. 257–77, 1901; also Nat. Geog. Mag., Vol. XII, pp. 180–96, 1901.

Attention is called to the fact that nowhere else on the earth is such magnificence of mountain fiord and glacier scenery to be found. It is thought that glaciation has been a very important factor in shaping the fiords and rounding the mountain surfaces. The present glaciers, though far larger than those of Switzerland, are trifling compared to their predecessors. There is a narrow strip of low coast from the Mount. St. Elias region westward, and the Alaskan coast of Bering sea is mainly low and marshy. The Yukon delta covers thousands of square miles. The Yukon river is navigable for small steamers throughout its course in Alaska. The interior of Alaska is but little known, but so far as explored is found to be traversed by a system of rivers navigable for canoes, though in some cases interrupted by rapids and low falls. The Pacific coast climate is very damp and the skies are cloudy. It is much warmer than the coast of Bering sea, because the latter is practically a closed sea to which the warm waters of the Pacific do not have access. The interior is subjeet to a far greater range in temperature than the coast, there being a known range of about 150° Fahrenheit in certain localities along the Yukon.

MUIR, JOHN. *The Pacific Coast Glaciers.* Harriman Alaska Expedition, Vol. I, pp. 119–35, 1901.

The Sierra Nevada of California carry sixty-five small glaciers at altitudes of 11,000 to 12,000 feet. They are mainly between latitude 37° and 38°. On Mount Shasta a glacier extends down to 9,000 feet. The Cascade range of Oregon and Washington has groups of glaciers on the highest mountains. From Mount Ranier they descend to 3,000 to 4,000 feet above the sea.

In British Columbia and southeastern Alaska the broad lofty mountains along the coast are usually laden with ice, and the upper branches of nearly all the canyons occupied by glaciers. The highest and snowiest are between latitude 56° and 61°, and they afford a considerable number that discharge icebergs into the sea. This very snowy field is about 500 miles long and 100 miles broad, and probably includes

nine-tenths of the ice on the coast. Glaciers are very few and small north of latitude 65°.

There are about 100 large glaciers that do not reach the sea. The Malaspina is the largest, being about 20 miles by 65 or 70. Many are 2 to 4 miles wide. Of glaciers that flow out into the sea the author has seen twenty-eight, and knows of at least three more, while several fiords in Prince William sound remain unexplored. The southernmost is Leconte glacier in latitude 56° 50′. Three reach the sea in Taku Inlet and nine in Glacier bay. Of the last named the largest is the Muir glacier, which is twenty-five miles wide below the junction of the main tributaries, while the area of its basin is scarcely less than 1,000 square miles.

Glaciated surfaces testify to a grand continuous ice-sheet that not long ago fringed this coast along all the island region as far south as the strait of Juan de Fuca. Traces of former glaciation are also found farther north than the present limits, especially on the fiords below mountain ranges. Muir in 1881 noted evidences of glaciation in Plover bay on the Siberian coast.

SCHRADER, F. C., AND SPENCER, A. C. *Geology and Mineral Resources of a Portion of the Copper River District, Alaska.* House Doc. No. 546, 56th Cong., 2d Sess., 94 pages, 1901.

The Pleistocene deposits, physiography, and glaciation are discussed on pp. 58–82. There are heavy deposits of till and other glacial material in the Copper river basin, and the rounded topography of a glaciated region at higher altitudes. The deposits appear to have been formed by a glacier that had its source in the Wrangell mountains and adjacent Alaska range. Streams have cut to a depth of several hundred feet, and have not yet reached the level of the old rock floor.

In Prince William sound the evidence of glaciation extends to the water's edge along the mainland, for the shore is striated. Several of the islands also contain glacial material brought from the mainland. It is thought probable that the topography of the sound has been greatly affected by glacial erosion.

THE CORDILLERAN REGION OF THE UNITED STATES.

ARNOLD, RALPH. *The Pleistocene Geology of Southern California.* Abstract Science, N. S., Vol. XV, pp. 415, 416.

A summary statement of the marine Pleistocene of southern California with the subdivisions of Pleistocene formations.

ARNOLD, DELOS, and ARNOLD, RALPH. *The Marine Pliocene, and Pleistocene Stratigraphy of the Coast of Southern California.* Jour. Geol., Vol. X, pp. 117–38, 1902.

The faunas indicate a fluctuation of conditions along the California coast from the beginning of Pliocene times. Southern or warm conditions prevailed in the early Pliocene, northern or boreal in the late Pliocene and early Pleistocene, and warm conditions again in the remaining or greater part of the Pleistocene.

DILLER, J. S. *Glaciation of Mount Mazama.* Professional Paper No. 3, U. S. Geol. Survey, pp. 41–4, 1902.

This paper, which discusses the geology of the Crater Lake National Park, contains a brief discussion of the glaciation. Mount Mazama was a volcanic cone which

apparently collapsed as a result of the withdrawal of the liquid interior of the cone at a time subsequent to the glaciation. By this ingulfment seventeen cubic miles of material is thought to have disappeared. A correlative effusion at some other point is likely to have occurred, but it has not yet been located.

This mountain, which once occupied the position of Crater lake, had glaciers whose deposits and striæ are to be found on the rim of the crater and the mountain slope outside, but not on the slope toward the lake. On the lower slope of the mountain were tongues of glacier ice occupying the valleys only, but at the level of the rim (about 8,000 feet A. T.) nearly all the surface was glaciated. Ground moraine material is widespread, and a few terminal moraines occur. Mention is made of one which is 200 feet in height. Canyon-cutting by glaciers is also a marked feature.

FAIRBANKS, H. W. *Lake Chelan, Washington.* Abstract Science, N. S., Vol. XV, pp. 412, 413, 1902.

The Lake Chelan valley was occupied in recent times by one of the largest glaciers on the eastern slope of the Cascade range. Previous to that there was another lake in the valley at a somewhat lower level, which must have emptied into the Columbia river. The author holds that the great depth of the lake is due, not to the erosion by the glacier, but to stream erosion, and this erosion must have occurred prior to the formation of the Columbia lava plateau. A morainal dam holds the lake to its present level of 325 feet above the Columbia river. The author knows no reason to suspect that bed-rock will be encountered above the level of the Columbia river.

FAIRBANKS, H. W. *Pyramid Lake, Nevada.* Pop. Sci. Monthly, March, 1901.

A popular discussion of the features of this lake and of the history involved in the greater Lake Lahontan which once covered this site.

FENNEMAN, N. M. *The Arapahoe Glacier in 1902.* Jour. Geol., Vol. X, pp. 839–51, 1902.

A glacier formerly nine miles long is now reduced to a mile in length and occupies a cirque opening eastward to North Boulder creek in Colorado. Deficiency of snow the past three winters and excessive melting in the summers give exceptional opportunity for study and bring out features not known before. The glacier is really much branched, because of inequalities of the rock-bed, and has interesting moraines and crevasses and a prominent *bergschrund* at the line between the névé and the glacier proper. There is evidence of an uplift, but it is thought to have long antedated the glaciation.

GANNETT, HENRY. *Origin of Yosmite Valley.* Nat. Geog. Mag., Vol. XII, pp. 86, 87, 1901.

This paper was called out by the appearance of a paper by H. W. Turner on the origin of the Yosemite valley,[1] in which the potency of a glacier for the work of erosion is denied. Gannett thinks that the gorges in the high Sierra were cut by glaciers and holds the view that the line of demarkation between the channels made by the ice, and the valleys made by the streams, can be determined almost to a foot.

[1] "The Pleistocene Geology of the South-Central Sierra Nevada, with a Special Reference to the Origin of the Yosemite Valley," *Proc. Calif. Acad. Sci.*, Vol. I.

HERSHEY, OSCAR H. *The Quaternary of Southern California.* Bull. Dept. Geol. Univ. Calif., Vol. III, pp. 1-30, 1902.

The paper discusses the orographic disturbances in the early part of the Quaternary which lifted upper Pliocene beds to altitudes several thousand feet above the sea. A provisional scheme of classification is then brought out, which is expressed in the table below. The last column represents mere suspicions as to relative lengths of the different epochs.

TABLE OF QUATERNARY CONDITIONS.

	Recent Period	Modern Epoch		Deposition	Land-Level Below Normal	Length Ratio 5
Quaternary Era	Pleistocene Period	Le Conte's Sierran Period	Glacial Epoch	*Not represented*	*Not known*	5
			Not named	Erosion	Normal	10
			San Pedran Epoch	Deposition	Below normal	5
			Los Angelan Epoch	Erosion	Normal	75
			Red Bluff Epoch	Deposition	Below normal	10
			Santa Claran Epoch	Erosion	Normal	890

HERSHEY, OSCAR H. *The Term Sierran.* Am. Geol., Vol. XXIX, pp. 88-95, 1902.

It is considered doubtful if the contemporaneity of uplift on the Pacific coast with that in the eastern part of the United States has evidence to amount to a demonstration. For this reason it seems premature to attempt to correlate erosion cycles on opposite sides of the continent. The Sierran valleys cannot be directly compared with the Ozarkian valleys of the Mississippi basin. It appears highly probable that the Sierran excavation on the Pacific coast began before the opening of the Glacial epoch of the eastern states and was contemporaneous in part with the Ozarkian. But it is still in progress and was only slightly affected by glaciation in the high Sierra Under LeConte's definition Sierran covers, apparently at least, part of the Ozarkian and nearly all of the Glacial epoch. The so-called Glacial epoch of the California mountains was probably one-twentieth or one-fiftieth of the Glacial epoch of the eastern part of the United States. The author does not attempt to use "Ozarkian" on the Pacific coast, nor "Sierran" in the interior of the United States.

HILGARD, E. W. *The Débris Fans of the Arid Regions in their Relation to Water Supply.* Abstract, Science, N. S., Vol. XV, p. 414, 1902.

The structure of the débris fans is described and the value of these fans in forming natural storage and regulating reservoirs for water is brought out.

HILGARD, E. W. *A Sketch of the Pedalogical Geology of California.* Abstract, Jour. Geol., Vol. IX, pp. 74, 75, 1901; also Bull. Geol. Soc. Amer., Vol. XII, pp. 499-500, 1901.

The paper discusses the soil conditions, including also the difference between rock decomposition in arid and humid climates. In the humid regions loams and clay soils are produced, while in arid regions the soils are sandy and dusty unless derived from pre-existing clay formations which give rise to "adobe." In the arid regions there is a uniform soil mass to a depth of four to ten feet, with practically no subsoil,

and these soils almost universally contain high percentages of lime and potash, because not subject to the leaching process which affects the soils of the humid regions.

RITTER, WILLIAM E. *Subsidence of Santa Catalina Island in Recent Geological Times.* Science, N. S., Vol. XIV, pp. 575–7, 1901.

A submerged cobblestone beach three quarters of a mile to a mile out to sea from the present shore is cited in proof of the subsidence.

SALISBURY, R. D. *Glacial Work in the Western Mountains in 1901.* Jour. Geol., Vol. IX, pp. 718–31, 1901.

Reports results of investigations by several parties in northwestern Montana both east and west of the Rocky mountains; in the mountains of New Mexico, and in the Wasatch mountains.

The work east of the Rockies in Montana determined the limits of the northeastern ice-sheet and developed evidence concerning moraines of fourteen glaciers from the Rocky mountains. The work west of the Rockies was largely given to mapping the moraines of glaciers which extended southward in the lowlands and valleys.

In the Wasatch the positions of fifty Pleistocene glaciers exceeding one mile in length were determined, as well as traces of smaller glaciers and more than a dozen névé fields. Several of the glaciers reached the shore of Lake Bonneville, and the moraines of at least three of them are partially buried by the fluviatile deposits near the shore or possibly by the shore deposits. The altitude necessary to give rise to a glacier in that region was 8,000 to 9,000 feet. The glaciers were more numerous and larger, and the glaciation more vigorous, on the western slope than on the eastern, because of larger catchment basins and heavier snowfall. These mountains afford evidence of two widely separated episodes of glaciation.

In the New Mexico Rockies an altitude of 11,700 to 12,000 feet was necessary to produce glaciation. At least no evidence was found on peaks of lower altitude, though the search was not exhaustive. The longest glacier track is seven miles, and extends down to 9,200 feet.

It was also discovered that the Spanish Peaks of Colorado were once glaciated on their northern slopes.

STONE, G. H. *Note on the Extinct Glaciers of New Mexico and Arizona.* Science, N. S., Vol. XIV, p. 798, 1901.

The former occurrence of glaciers on the La Plata and San Juan mountains of southwestern Colorado is referred to, an account of which had previously been published. The Conejos range of the San Juan in New Mexico was glaciated for only thirty to fifty miles south of the Colorado-New Mexico line. The Sangre de Christo range both in Colorado and New Mexico was glaciated, and glaciation extended nearly to Santa Fé. The farthest southwest that evidences of glaciation were found in Arizona is near Prescott. The névé of this glacier scarcely rose above 9,000 feet. The occurrence of glaciation so far south (latitude 34° 30′) was probably due to great snowfall owing to proximity to the ocean. It is suggested that glaciers may have existed on the lofty Mogallon mountains of New Mexico and Arizona which had not been examined.

TURNER, H. W. *A Post-Tertiary Elevation of the Sierra Nevada.* Abstract, Science, N. S. Vol. XV, pp. 414, 415, 1902.

A comparison is made of the grades of the Tuolomne river in Neocene times and the present, showing a grade of 142 feet to the mile for the Neocene, in the 33 miles above the mouth of Piute creek and 92 feet to the mile for the present channel. The Neocene stream flowed in a broad channel making deposits, which indicate comparatively gentle grades, though they are scarcely so marked on this river as on streams farther north. It is thought that the grade was at least as low as that of the modern stream, so that the present grade of the Neocene channel is much greater than the grade at the time it was occupied by the stream, and this must have been brought about by a differential uplift on the east.

Princeton Patagonian Reports. Vol. I. Narrative and Geography. By J. B. HATCHER. Published by the University, 1903; pp. 314; pls. L.

NO BETTER augury could be desired for the success of the Princeton Patagonian Reports, the publication of which has been eagerly awaited, than is furnished by this, the initial volume of the series. Although entitled "Narrative and Geography," this handsome volume contains much more than the mere record or field-notes of an explorer's itinerary, being as a matter of fact replete with all manner of observations on the natural history, geology and physiography of the region visited. A Nansen, a Stanley, in fact no one short of a trained naturalist could have produced such a work, which is of the order one might expect from a Humboldt or Darwin. Without doubt the present contribution ranks as one of the most noteworthy that has yet appeared concerning the physical and biological features of the lower extremity of the South American continent.

One cannot review this work of Mr. Hatcher without appreciating the justice of Professor Scott's tribute, who remarks in the editorial preface that, "the whole forms a monument of energy and skill which it is difficult to characterize without using terms which savor of exaggeration." Three large monographs dealing with the rich palæontological material brought back from South America are promised by Professor Scott, and he further states in regard to Mr. Hatcher's stratigraphic determinations, that they were "most useful, making possible for the first time a rational account of the geology of large areas in southern Patagonia." It deserves also to be remembered, in judging of the extent of these achievements, that an elaborate volume by Drs. A. Ortmann and T. W. Stanton on the invertebrate material has already made its appearance.